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NOTES AND MEMORANDA

THE DUN-GIBSON INDEX NUMBER

In the August issue of this JOURNAL, Professor J. Pease Norton called attention to " a revised index number for measuring the rise in prices " which Thomas Gibson has recently begun to publish in continuation of the suspended Dun Index. A critical examination of the merits of this new series may be serviceable to economists.

I

" For a great many years," as Professor Norton says, " the Dun index numbers had the approval of the business world." What is more surprising, they won the sanction of the Treasury Bureau of Statistics, and for some time were regularly re-published in its official documents, including the Statistical Abstract of the United States.

Whether they merited this popular approval and this official recognition is highly questionable. No one knows what value to set upon the Dun series, for the simple reason that the compiler never disclosed what data he used. Dun's Review stated regularly that 350 commodities were included, and that the price of each was " multiplied by the quantity annually consumed by each inhabitant, as nearly as may be ascertained by statistical records." But, for lack of space, the Review never printed the list of articles, never stated the sources from which quotations were taken, and never explained how " the quantity annually consumed by each inhabitant " was estimated. Hence the results had to be accepted on faith. Their vogue was due to " prestige value."

But no mystery veiled the distinguishing feature of the Dun series. Unlike most other index numbers, it was not an average of relative prices, but a sum of actual prices in dollars and cents. It professed to show "the cost of a year's supplies of all the necessaries of life" for a single person.[1] Dun's Review soberly explained that, "While these figures can not be considered exact, the approximation is sufficiently close to attain the desired result, and the ratio being constant the comparison with different dates *shows to a cent the rise or fall in cost of living.*"[2]

This pretence of showing accurately changes in cost of living was a curious blunder; for the quotations used in constructing Dun's series were taken from wholesale markets. That changes in prices at wholesale differ materially from changes in prices at retail is well known. The best available evidence concerning the nature and degree of this difference is given by a table showing the average relative prices of the 25 foods for which the Bureau of Labor publishes both wholesale and retail quotations.[3] According to this table, changes in wholesale prices usually indicate

TABLE I

RELATIVE PRICES OF 25 FOODS AT WHOLESALE AND RETAIL
Arithmetic Means. Average prices 1890–99 = 100

	At Wholesale	At Retail		At Wholesale	At Retail
1890	109	102	1899	96	99
1891	113	104	1900	101	101
1892	105	102	1901	104	105
1893	115	105	1902	113	110
1894	103	100	1903	107	110
1895	96	98	1904	106	110
1896	84	95	1905	107	111
1897	86	96	1906	113	114
1898	93	98	1907	117	119

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[1] Hence the practice of multiplying the price of each article by the consumption *per capita.*

[2] Dun's Review, September 7, 1901. Quoted in Bulletin of the Department of Labor, March, 1902, p. 211. Italics mine. "The ratio being constant," probably refers to the system of weighting which is explained below.

[3] The commodities included are: apples-evaporated, beans; beef-fresh; beef-salt; bread-wheat; butter, cheese; coffee, corn meal, eggs, fish-salt; flour-wheat; lard; milk; molasses, mutton, pork-bacon; pork-dry or pickled; pork-ham; pota-

the *direction* in which retail prices are moving. But they cannot be trusted even so far, since the fluctuations of 1902–04 present an exception to the rule. As an index of *degree of change* in cost of living, on the contrary, the wholesale figures are altogether untrustworthy. The average variation from one year to the next is more than twice as great for the wholesale series in the table as for the retail series — 5.9 points against 2.4. It follows that the Dun index number is not what it purports to be — an accurate measure of changes in cost of living.

Whatever merits the Dun series possesses, then, must be merits as an index of changes in wholesale prices. But if so much be granted, the advantages of Dun's system of weighting are open to question. The weights employed are food 50%, clothing 18%, and minerals and miscellaneous goods each 16%. Professor Norton regards this scheme of weights as worthy of continuation, because American families with incomes of less than $700 have been found to make 47% of their expenditure upon food, 14% upon clothing, and 39% upon other things. No doubt, weights derived from family budgets are the best for use in tables of retail prices which show changes in cost of living. But it does not follow that proportions of family expenditure are the best guage of the relative importance of commodities in wholesale trade. Indeed, there is a measure of absurdity in applying such weights to groups of commodities like pig iron, lime, fertilizers, lead, hides, and brick, which do not enter into family budgets.[1] Consumers' goods made from these materials might logically be weighed in this manner; but not the materials themselves.

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toes; prunes; rice; sugar; tea; vinegar. To make the comparison as fair as possible, I have used the retail prices for the North Atlantic States when the wholesale market is New York, and for the North Central States when the wholesale market is Chicago.

The Bureau of Labor's comparison between the relative prices of 30 foods at retail and 54 foods at wholesale is less trustworthy than the present table. Nevertheless it yields substantially similar results. See Bulletin of the Bureau of Labor, July, 1908, pp 195–7.

[1] These articles are among the few definitely known to be included in Dun's list. See Statistical Abstract of the United States, 1907, p. 569, note.

As the vogue of the Dun Index grew, the compiler became more ambitious and began to extend his figures backward, until finally he made an unbroken series for every year since 1860. Any one who has dealt with American price quotations must wonder enviously where this bold statistician found trustworthy records of prices and consumption for his 350 commodities over this long period of time. If he really had the data, he wronged all students of the subject by not publishing them, or at least indicating his sources. If, on the other hand, he was forced by scantiness of quotations to work with fewer commodities, or to make substitutions as he went further back, then he tacitly compromised the integrity of his series. Not until the substantial continuity of the quotations used has been guaranteed by a frank statement can confidence be felt in the comparability of the figures for different years and decades.

At best, then, Dun's index number shows the fluctuations in wholesale prices of an unknown and presumably changing list of commodities, weighted by *per capita* consumption, ascertained no one knows how. Whether it was worth while to attempt a continuation of this dubious series after Dun's Review dropped it is doubtful. For, however perfect the continuation, comparisons between the new figures and the old must always be attended by the uncertainty which clouds the title of the latter.

II

But is the Gibson Index really a continuation of the Dun series ?

Two important changes have been made in the method of computation. First, the number of commodities included has been reduced from 350 to 50, and the latter list has been published. Second, the character of the series has been changed from a sum of wholesale prices of a year's, supplies of necessaries for one person in dollars and cents to an average of relative prices. These relative prices are taken ready-made from the Bureau of Labor and are based upon average actual prices in the decade 1890–99. To graft these relative prices upon the Dun series, it was necessary to multiply them by 0.843. This figure represents the average of the Dun numbers for 1890–99, corresponding to an average of 1.000 for the same period in the series borrowed from the Bureau of Labor.[1]

Aside from this multiplication by 0.843, Professor Norton's case for treating the new average of 50 relative prices as a continuation of the old sum of 350 actual prices rests upon the use of what he treats as identical weights. Dun's plan of multiplying the price of each commodity by its *per capita* consumption is given up, and the pretence that the results measure changes in cost of living is all but dropped. The continuity of weights consists simply in making the group of foods as a whole count for 50% of the total, and the groups of textiles, minerals, and miscellaneous articles count for 18%, 16%, and 16% respectively. To show that this method of manipulating relative prices drawn from the Bureau of Labor does actually produce results nearly identical with Dun's index number, Professor Norton compares the new Gibson and the old Dun figures for four dates, the year 1896, and the months January, February, and March, 1907 — and finds that the average differences do not exceed one point.

Such close agreement is surprising. For past experience in dealing with index numbers has established the belief that systems of weighting exercise less influence upon the results than the number and character of the series to which the weights are applied.[2] That a partial similarity of weights should have power to make an average of 50 relative prices come out as a rule within one point of a sum of 350 actual prices seems improbable. I have, therefore, computed the Gibson index number on the plan explained by

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[1] Of course this short method of transposing relative prices to a new basis does not yield strictly accurate results But to recompute the relative prices of 50 commodities on the basis, average actual prices in 1890–99 = 84 3, would have involved greater expense.

[2] Compare A. L. Bowley, Elements of Statistics, 2d edition, p. 224.

Professor Norton for all the years covered both by the Bureau of Labor data and by Dun's series. Table II presents the results.[1]

TABLE II

Comparison between the Gibson and Dun Index Numbers 1890–1906

	Gibson	Dun	Difference
1890	96.0	91.6	+4.4
1891	96.9	96.1	+0.8
1892	89.1	90.0	−0.9
1893	89.2	90.6	−1.4
1894	79.4	83.3	−3.9
1895	78.8	81.5	−2.7
1896	72.3[2]	74.3	−2.0
1897	74.9	72.5	+2.4
1898	80.1	77.8	+2.3
1899	86.3	85.2	+1.1
1900	92.9	91.4	+1.5
1901	91.4	91.5	−0.1
1902	97.8	101.9	−4.1
1903	96.3	99.5	−3.2
1904	97.8	97.2	+0.6
1905	98.8	98.3	+0.5
1906	102.7	105.2	−2.5

In the 17 years covered by this table, Gibson's and Dun's index numbers disagree three times about the direction in which prices were trending. In 1896–97 the Gibson figures rise while the Dun figures fall; in 1900–01 the Gibson figures fall while the Dun figures rise; in 1903–04 the Gibson figures again rise while the Dun figures fall. The difference between the two series is less than one point in five years, between one and two points in three years, between two and three points in five years, between three and four points in two years, and over four points in two years. In eight years the Gibson figures exceed the Dun, in nine years the Dun figures exceed the Gibson. One series makes 1896, the other 1897 the year of lowest prices. The sum of the differences is 34.4 points, a trifle more than two points on the average, or twice the difference found by Professor Norton.[1]

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[1] To make sure that I was using the same series as Professor Norton, I checked my list by the relative prices for January, 1907, which he publishes. One discrepancy appeared. Professor Norton enters the relative price for "Wool, Ohio, fine fleece" as 125.1; the Bulletin gives 127.1. But Professor Norton's footing for textiles indicates that the discrepancy is merely a misprint.

[2] My result for this year differs by 0.1 from Professor's Norton's — 72.2.

Lest it be thought that an average difference of little more than two points between two series of index numbers justifies a statistician in regarding one series as a continuation of the other, I may point out that the Gibson Index differs less from two series with which it is supposed to be unrelated than from the series which it is supposed to continue. Both of these series come from the Bureau of Labor. Since the Gibson figures were shifted from the Bureau's basis of average actual prices in 1890–99 to the Dun basis through multiplication by 0.843, they can be shifted back again through division by that same number. Then comparison is feasible. One of the series in the next table shows the Bureau's own figures for "all commodities" — about 250 in number. The other is made from the Bureau's relative prices by using only the averages of groups of closely related goods — like different kinds of cotton sheetings, shingles, window glass, etc.[2] This improvement reduces the number of series entering into the grand average from 250 to 145.

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[1] A minor cause of difference which Professor Norton does not mention, is that the Dun figures which he uses refer to prices on July 1st of each year, whereas the Gibson figures which he publishes as a continuation for 1907–09 represent average prices for every month in the year. I have had to follow his example in using annual averages in the comparison with Dun, since the Bureau of Labor has not published monthly relative prices by single commodities for years before 1902.

[2] The groups for which I have used averages are as follows cattle, hogs, sheep, beef, bread, crackers, bread-loaf, butter, fish, flour-wheat, meal-corn, pork, sugar, blankets, boots and shoes, carpets, cotton flannels, cotton yarns, drillings, ginghams, leather, overcoatings, sheetings, shirtings, silk, underwear, women's dress goods, worsted yarns, wool, coal-anthracite, coal-bituminous, petroleum-refined, bar iron, nails, pig iron, tools, builders' hardware, oak, pine-white, plate glass, shingles, window glass, earthen-ware, furniture, glassware, table cutlery, wooden ware, paper, tobacco.

The purpose is to get a simple arithmetic mean, which is the resultant of as many independent price-factors as possible. It might be desirable to go even further, and use but one average series each to represent all cotton and all woolen textiles As the next table shows, the new figures are somewhat more sensitive than the old, but the differences are slight.

TABLE III

COMPARISON BETWEEN THE GIBSON AND THE BUREAU OF LABOR INDEX NUMBERS

	Gibson	Bureau of Labor		Differences	
	÷ 0.843	250 series	145 Series	250 series	145 series
1890	113.9	112.9	114.1	+1.0	−0.2
1891	114.9	111.7	112.7	+3.2	+2.2
1892	105.7	106.1	106.1	−0.4	−0.4
1893	105.8	105.6	105 0	+0.2	+0.8
1894	94.2	96.1	95.6	−1.9	−1.4
1895	93.5	93.6	92.8	−0.1	+0.7
1896	85.8	90.4	88.8	−4.6	−3.0
1897	88.8	89.7	88.7	−0.9	+0.1
1898	95.0	93.4	93.5	+1.6	+1.5
1899	102.4	101.7	102.5	+0.7	−0.1
1900	110.2	110.5	111.3	−0.3	−1.1
1901	108.4	108.5	109.6	−0.1	−1.2
1902	116 0	112 9	113.7	+3.1	+2.3
1903	114 2	113.6	113.8	+0 6	+0.4
1904	116.0	113.0	113 9	+3.0	+2.1
1905	117.2	115.9	115.8	+1.3	+1.4
1906	121.8	122.5	122.3	−0.7	−0 5

The differences shown by this table between the Gibson and Bureau of Labor figures are distinctly smaller than those shown by Table II between the Gibson and Dun figures. The sums of the differences are 23.7 points for the Bureau's own series, and 19.4 points for the revised series. The latter sum is not much more than half of the 34.4 points by which Gibson's Index differs from Dun's.[1]

Comparison may be made also with Bradstreet's Index. This series is described as showing "the totals of the prices per pound of 96 articles," on the first day of each quarter from 1892 to 1898, and on the first day of each month from 1899 to date. The averages by years for 1892 to 1906, as computed by the compilers, are shown in the first column of the next table.[2] A process analogous to that applied by Professor Norton in shifting the Bureau of Labor series to Dun's basis for 1890–99, may be applied in shifting the Bradstreet series approximately to Gibson's basis for 1892–99. The sum of the figures for 1892–99 is 650.1 in Gibson's Index, and 54.23 in Bradstreet's. The first sum divided by the second gives 11.987. The second column of the table shows Bradstreet's series multiplied by that number. The last two columns show how much both these revised Bradstreet and the Dun figures differ from the Gibson figures. It turns out once more that the new series agrees better with a supposedly unrelated index number than with that which it purports to continue.

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[1] Had the transposing been done by reducng the Bureau of Labor series to the lower level of the Gibson series, instead raising the latter to the higher level of the Bureau's series, the differences would have been smaller still.

[2] Bradstreets, Aug. 13, 1910, p. 526.

TABLE IV

COMPARISON BETWEEN THE GIBSON AND THE BRADSTREET INDEX NUMBERS

1892–1906

	Bradstreet's Index Number		Gibson's Index Number	Differences between Gibson's Index and	
	Original	Multiplied by 11.987		Bradstreet's × 11.987	Dun's
1892	7.78	93.3	89.1	−4.2	−0.9
1893	7.53	90.3	89.2	−1.1	−1.4
1894	6.68	80.1	79.4	−0.7	−3.9
1895	6.43	77.1	78.8	+1.7	−2.7
1896	5.91	70.8	72.3	+1.5	−2.0
1897	6.12	73.4	74.9	+1.5	+2.4
1898	6.57	78.8	80.1	+1.3	+2.3
1899	7.21	86.4	86.3	−0.1	+1.1
1900	7.88	94.5	92.9	−1.6	+1.5
1901	7.57	90.7	91.4	+0.7	−0.1
1902	7.88	94.5	97.8	+3.3	−4.1
1903	7.94	95.2	96.3	+1.1	−3.2
1904	7.92	94.9	97.8	+2.9	+0.6
1905	8.10	97.1	98.8	+1.7	+0.5
1906	8.42	100.9	102.7	+1.8	−2.5
Sums of the differences				25.2	29.2

As has been said, experience did not justify the man who planned Gibson's Index in thinking that a partial identity of weights would suffice to weld it smoothly to Dun's.

But his ill fortune passes expectation. Not knowing what commodities entered into the old series, he took long chances, and they have turned against him. Certainly no one could have foreseen that three other series taken at random, with widely varying lists of commodities and widely varying weights, would each happen to agree better than Dun's with the new series.

Gibson's Index, then, is not a legitimate heir of Dun's. But the fact that it comes fairly close to the latter and closer still to three other series, affords welcome evidence of the reliability of the common method of measuring changes in prices. Five index numbers, made from quotations for 350, 50, 250, 145, and 96 commodities respectively, all yield much the same results. Confidence in the representative character of each series is confirmed by the substantial agreement of the others.

III

Tho unsuccessful as a continuation of Dun's series, the Gibson Index deserves to be judged upon its own merits.

Its chief defect is obscurity of meaning. A technical description would run as follows: an arithmetic mean of the relative prices of 50 staple commodities at wholesale, computed on the basis of average actual prices in 1890–99, multiplied by 0.843, and classified in four groups, each weighted according to a scheme borrowed from Dun's index number, and justified by family expenditures at retail prices as shown by a collection of working-men's budgets. It is not easy to interpret such figures.

Clearly the Gibson Publishing Company would enhance the value of their index number by simplifying its character. If they dropped the vain pretence of continuing Dun's series, they would get rid both of the cumbrous method of computation and the obscurity of meaning which the effort at continuation involves. Then they might strike a simple arithmetic mean of relative prices which would be intelligible. This plan would make the 22 foods count as 44% of the 50 commodities, the 9 textiles and 9 minerals as 18% each, and the 10 miscellaneous goods as 20%. The results computed in this fashion run as follows.

TABLE V

THE IMPROVED GIBSON INDEX NUMBER, BY YEARS, 1890–1909
Arithmetic Means, Average Actual Prices, 1890–99 = 100

1890	114.0	1900	111.6
1891	113.9	1901	109.2
1892	105.1	1902	116.2
1893	105.2	1903	115.3
1894	93.9	1904	116.3
1895	93.9	1905	117.9
1896	86.6	1906	123.4
1897	89.2	1907	131.6
1898	95.0	1908	125.0
1899	103.4	1909	132.1

Such simplification is all that is needed to make the Gibson index number a model of its kind. For, as Professor Norton says, its composition "in the light of the statistical quality and importance of the articles, is excellent." But its chief advantage over rivals is the weekly publication which is promised. After such a weekly series had been maintained several years, it would afford a better basis than the monthly tables for investigating the relations between changes in prices of commodities at wholesale on the one hand, and changes in prices of stocks, rates of interest, activity of business, etc., on the other hand.

But useful as the Gibson Index might prove, neither it, nor any other single series can justly claim to be a satisfactory measure of the rise and fall of prices. For the kind of index number wanted must always depend upon the end in view. The very features which make a series admirable for one purpose may disqualify it for another. Already the purposes for which economists use index numbers are many, and doubtless they will multiply in the future. Hence the great value of the plan which Colonel Wright adopted in the Bureau of Labor — that of recording the actual and relative prices of a long list of commodities, from which investigators may make such selections and combinations as their ends require.

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THE SOMERS SYSTEM OF REALTY VALUATION

THE quadrennial[1] revaluation of real estate for taxation, which has been in progress in Ohio during the present year, has revived the old problems relative to proper methods of taxation, and has given rise to new ones. The pressure of the present burden of taxation[2] has led to a general demand for reforms in the existing system of valuation, under which gross inequalities have entered into the assessment of real estate, both as between different localities and as between different parcels of real estate in the same locality.[3] The popular demand everywhere has been for an enforcement of the constitutional and legal provisions requiring all property to be assessed at its fair cash value. Appraisal Boards throughout the state have been stimulated by this public outcry to greater efforts in the pursuit of their duties, and in the use of new methods of determining true valuations. One of the most elaborate of these methods is that which has been adopted in Cleveland, Ohio, the "Somers System of Realty Valuation."[4] Its essential features will here be described briefly.

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[1] Formerly decennial. Beginning with 1910, the appraisement is to be quadrennial. See Acts of the Ohio Legislature, Session of 1909, p. 81.

[2] The Cleveland tax rate in 1909 was $3.37 per $100.

[3] See Report of the Ohio Tax Commission, 1908.

[4] So-called from its inventor, Mr. W A. Somers, of St. Paul, Minn. The system is the product of many years of experience in assessors' offices and of considerable study of the whole subject of real estate values. It has been used successfully in St. Paul and in Ramsey County, Minn, for both city and rural valuations, and has been installed in Columbus, Ohio, for the present appraisement of real estate Parts of the system were used, under Mr. Somers' direction, by the New York Appraisal Board of 1909, but the fundamental features of the plan were not there employed.